

THE SOLAR WIND VELOCITY AND ITS CORRELATION WITH GEOMAGNETIC, SOLAR AND COSMIC RAY ACTIVITY

by

Conway W. Snyder and M. Neugebauer
Jet Propulsion Laboratory, California
and

U. R. Rao *
Graduate Research Center of the Southwest

PRESENTED BY: U. R. RAO

GPO PRICE \$ _____

CSFTI PRICE(S) \$ _____

Hard copy (HC) 1.00Microfiche (MF) 50

653 July 65

1. INTRODUCTION

In this report we discuss the correlation of plasma velocity measured by Mariner II with various indices of solar and terrestrial activity during more than 4.5 solar rotations covering the period 28 August through 31 December 1962 (day 240 to 365). The daily mean and the six-hourly mean plasma bulk velocities have been derived from approximately 40,000 spectra received from the plasma probe which consisted of a single electrostatic spectrometer pointing within 0.1 degrees of the center of the sun.

2. EXPERIMENTAL RESULTS

Figures 1a and 1b show the plot of the daily mean plasma velocity, the planetary indices K_p and the sunspot and C. R. activity. The plasma velocity does not show any correlation either with the cosmic ray diurnal amplitude and time of maximum or with the overall solar activity as measured by the sunspot

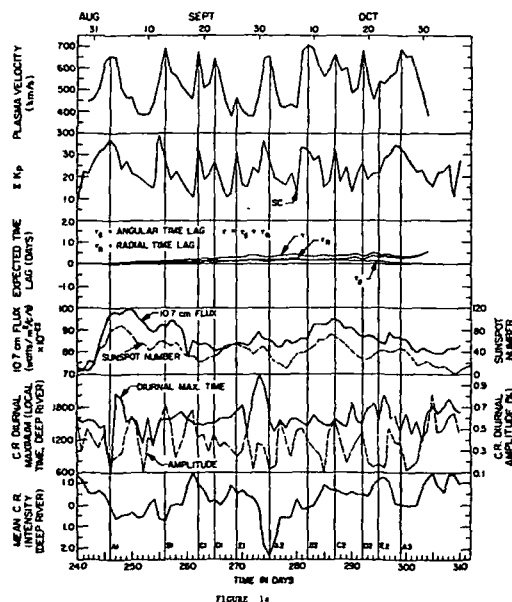


FIGURE 1a

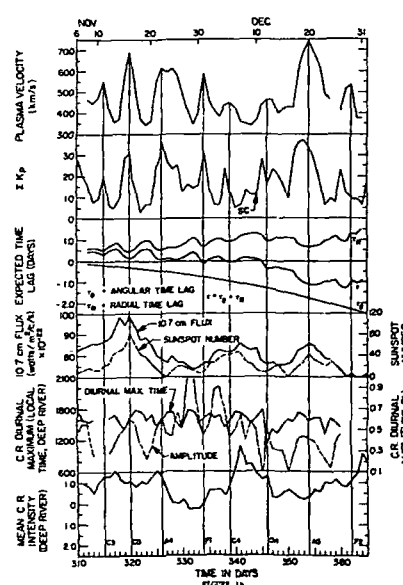


FIGURE 1b

* On leave from Physical Research Laboratory, Ahmedabad, India

1065-30724

(THRU) _____

(CODE) 29

(CATEGORY) _____

(ACCESSION NUMBER) 4

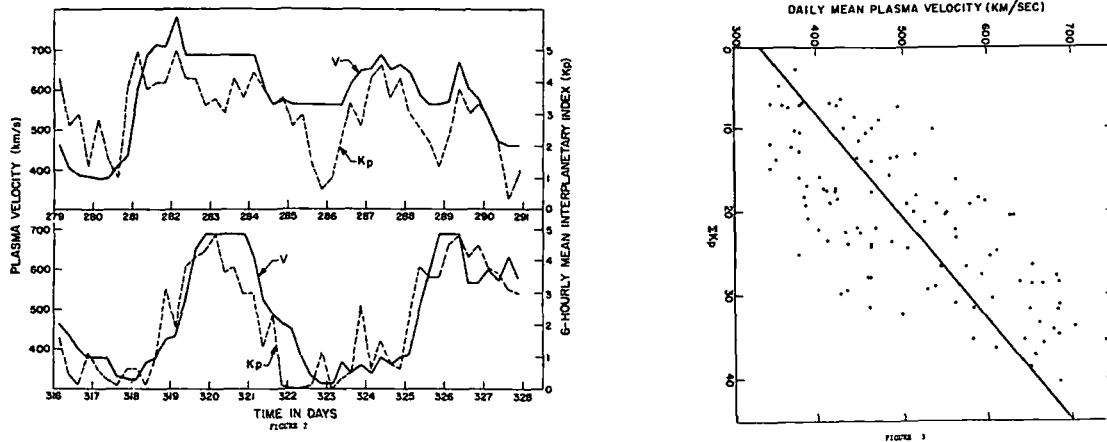
(PAGES) 64091

(NASA CR OR TMX OR AD NUMBER) _____

FACILITY FORM 602

number and 10.7 cm flux. However, a remarkable correlation exists between daily $\sum K_p$ and daily mean plasma velocity with no time lag, except after day 352 when both the "expected" and the observed time lags were approximately one day. Every major peak and trough in plasma velocity (indicated in Figure by vertical lines) was associated with a corresponding peak or trough in $\sum K_p$, the correlation coefficient between the two for the entire period being $0.73 \pm .04$.

Figure 2 shows the six-hourly mean plasma velocity and K_p for three selected periods. Even when the plasma velocity was continuously high for a few days, K_p did not become small. The correlation between six-hourly mean plasma velocity and K_p was 0.65 ± 0.04 . Preliminary analysis shows no correlation between K_p and dv/dt , the flux or the kinetic pressure. Our results



conclusively prove that K_p is a measure of the plasma velocity and not of the time rate of change of plasma velocity.

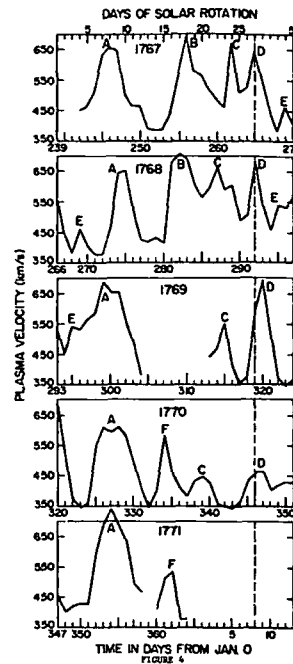
The relationship between K_p and the daily mean plasma velocity is illustrated in Figure 3. The best fit for the data is given by the straight line

$$V \text{ (km/sec)} = (8.44 \pm 0.74) \sum K_p + (330 \pm 17)$$

$V = 330$ km/sec, corresponding to $\sum K_p = 0$ represents the minimum plasma velocity which can excite disturbances in the geomagnetic field. Applying this relation we find that the mean plasma velocity during 1957 was 510 km/sec. Comparing the extrapolated velocity of 475 km/sec with that measured by Explorer X just at the boundary of the magnetosphere on 26 March 1961, we conclude that the velocity gets attenuated by a factor of 1.6 across the shock front ahead of the cavity.

Each of the peaks shown in Figure 1 exhibits a very strong 27-day

recurrence tendency (see Figure 4). The peaks are divided into five groups, A to E, where each member of a group represents an encounter with the same long-lived plasma stream. Only two of these were associated with Sc storms, the rest being associated with M-region storms. Particularly interesting are A series peaks which were associated with a region of the photosphere which, time after time contained from one to three calcium plages. Beginning in rotation number 1766 with McMath plage number 6504, this active region was still visible in rotation 1777. The complete solar and terrestrial relationships of these peaks are summarized in Table I.



3. CONCLUSIONS

1. There was always a measurably large plasma flow from the direction of the sun. Plasma velocity varied from day to day.
2. Plasma velocity is not correlated with the cosmic-ray diurnal amplitude or time of maximum or with the overall solar activity.
3. Plasma velocity is very strongly correlated with K_p . The relationship between K_p and velocity can be represented by the equation

$$V \text{ (km/sec)} = 8.44 \sum K_p + 330$$

where V and $\sum K_p$ are both daily values. Using this empirical relation, we find that (a) the daily mean plasma velocity averaged over a year varies from ~ 510 km/sec to ~ 330 km/sec from sunspot maximum to sunspot minimum, and (b) the plasma velocity measured near the earth by Explorer X was a factor of ~ 1.6 lower than the velocity of the interplanetary plasma on the day of observation.

4. The plasma velocity showed a very strong 27-day recurrence tendency and a close association with M-region storms, which indicates that M-regions are emitters of high velocity plasma.

A full account of these results will appear in the December issue of J.G.R.

TABLE I

Terrestrial Relationships													
Solar Relationships										Geomagnetic Storms			
Optical Region (Calcium Plage)										Radio Region		Decametric	
Classi- fication	Date of Observed Maximum Plasma Velocity	Date of CMP	McMath Plage Number	Return of Region	Latitude	Decimetric 9.1 cm Period of Activity	Metric 169 MC/S	Decametric 7.6-41 MC/S Date on which Continuum or Type IV Observed	Begin Date Time	End Date Time	Begin Date Time	End Date Time	
A1	246	245.0	6536	6504	N10	244-245		244.9	244 06xx	247 24xx			
A2	274	272.6	6562	6504	N12	-	Moderate	271.8	274 0100	275 19xx			
A3	300	298.3	6586	6504	N09	299	Strong	296.7	297 12xx	301 18xx			
A4	326	324.5	6618	6504	N11	-	Moderate	-	325 06xx	327 0500			
A5	354	351.7	6646	6504	N11	352-353	Strong	352.8	351 1500	356 1100			
B1	256	255.6	6554	new	S09	-	Moderate	255.6	255 0520	257 09xx			
B2	282	279.4	6567	6548	S12	277	Moderate	-	280 2025	284 15xx			
B4	334	332.5	6635	new	N00	Moderate	Moderate	-	334 0100	334 1800			
B5	362	360.5	6653	6635	N04	361	Little	358.8					
C1	265	263.6	6563	new	N00		Little	260.6 263.7					
C2	292	291.4	6581	6563	N03	Moderate	Strong	288.8	292 07xx	296 23xx			
C3	320	318.0	6614	6563	N04	315-318	Moderate	318.6					
C4	347	344.6	6644	6563	N04	342-345	Moderate						
287	287	285.4	6585	new	S14	286	Moderate		286 0800	288 09xx			
315	315	312.3	6606		S11		Strong	311.9					